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XIV. *Particulars of the Discovery of some very singular Balls of Stone, found in the Works of the Huddersfield Canal. By Mr. Benjamin Outram, Engineer to the Huddersfield Canal Company. Communicated by Sir Joseph Banks, Bart. K. B. P. R. S.*

Read April 21, 1796.

THE Huddersfield canal is to be carried through that chain of mountains which extends from the Peak of Derbyshire, in a northward direction through Yorkshire, &c. into and through a great part of Scotland, by pursuing from the navigation at Huddersfield a deep and narrow valley to Marsden, where it enters the north-eastern foot of one of these mountains, called Pule Hill, under which it is to be extended south-westwardly by a subterraneous cut or tunnel to the foot of Stand Edge Hill, or Brunn Clough, where it again excavates; and pursuing the bottom of a deep valley into Saddleworth, passes along the banks of the Tame to Ashton-under-Lyne, where it joins the canals that extend to Manchester, Stockport, Peak Forest, &c.

In the latter end of the year 1794, the miners employed by the canal company began to perforate the north-eastern foot at Pule Hill; the strata they first cut through consisted of a greyish coloured shale, the beds or laminæ of which did not lie quite horizontal, but dipped or inclined a little to the westward. The strata continued regular till the workmen had

perforated about 240 yards in length from the entrance of the hill, and were about eighty yards deep from the surface of the ground immediately over them, when they discovered on the north side of their work a *fault, throw, or break* of the strata, which was filled with shale, reared on the edge, and mixed with softer earth, and in some places with small lumps of coal. In continuing to pursue the direction of the tunnel, this fault occupied by degrees more of the space of the tunnel, for about forty yards in length, when it nearly occupied the whole tunnel, which is near four yards in width; and at about five feet from its southern margin it contained a rib of limestone, near four feet thick in the bottom, but not quite so thick at the top of the tunnel; and on each side this rib it contained balls of limestone promiscuously scattered, and of various sizes, from one ounce to upwards of 100lbs. weight.

The rib and balls of limestone were first found at about 280 yards from the north-eastwardly end of the tunnel, where it is about 90 yards in perpendicular depth from the surface; and the workmen have now pursued the tunnel to near 350 yards from the entrance, and the rib of limestone and balls continue nearly the same; the rib has varied a little in thickness, and has not pursued a straight line; it in one place nearly left the tunnel to the northward, but in a few yards turned southward, to its former direction. The limestone of the rib is not perfectly pure, that in the balls is still less so, but it makes a good lime for cement. The balls when broken appear to be mixed with a kind of pyrites, in small particles, near their outward edges; their form is very peculiar, being similar in all their sizes; it is not perfectly globular, being flattened a little on two opposite sides, which appear to have been

the poles when in a revolving state ; and each ball is more or less furrowed in a latitudinal direction, as if, when revolving round its axis, and taking its *fixed* from a more *fluid state*, it had met with some resisting substance.

Though the surface of this country is very rocky, it does not discover limestone any where within 20 miles of this tunnel ; yet if the strata near the limestone at Buxton to the south, and at Clitheroe to the north, are examined, it will appear probable that the base of these hills is limestone at *some depth*, and this *fault* discovered in the shale probably extends from the limestone bed beneath ; and the rib of limestone and balls, which, with other mixed substances, fill up this crevice or fault, were probably thrown thither from the mass beneath, by the volcanic eruption which first occasioned this *break* in the strata, or by some subsequent eruption of the same kind.